Student Name _____

P

DC Science

The District of Columbia Assessment of the Next Generation Science Standards

Biology Test Booklet

Practice Test

Unit 1

Welcome! Today you will take unit 1 of the DC Science Assessment Practice Test.

To respond to the tasks on this test, you may be asked to review information in the form of text, images, data tables, and graphs. Analyze all the information and tasks carefully and then respond to each task. You may need to read across multiple pages to see all the information. You will be allowed to use a calculator for all units in this test.

Some tasks require more than one response. You may look back at the information as often as necessary.

For tasks that ask you to explain, describe, or answer in your own words, write your responses in the space provided. You may use scratch paper to organize your thinking before writing your response in the space provided.

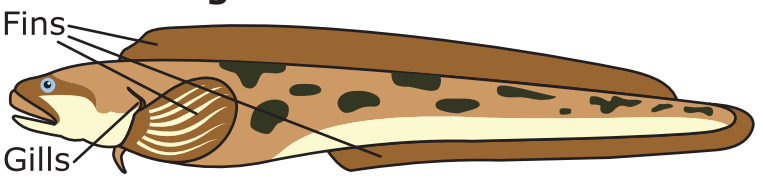
For tasks that ask you to fill in the blank spaces or write answers in the correct box, you may write the letter corresponding to the response or write the entire response in the blank space.

If you are unsure about an answer, select or compose an answer you think is the best response. You can always go back to the items you are unsure of after you've answered all other questions in the unit.

Finally, before beginning the test, please write your name on the top of the cover page and wait for the test administrator to inform you to turn the page.

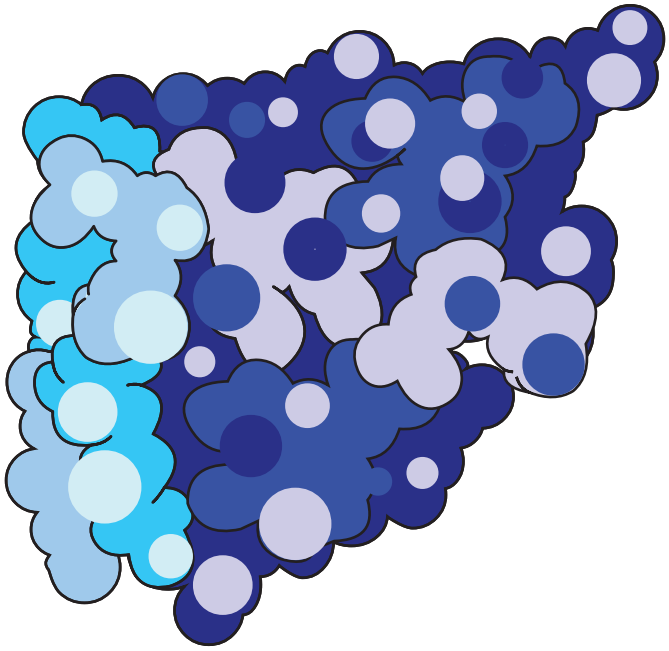
A researcher is studying ocean pout *(Zoarces americanus),* an eel-like fish found in the cold waters of the northwest Atlantic Ocean.

Figure 1. Ocean Pout



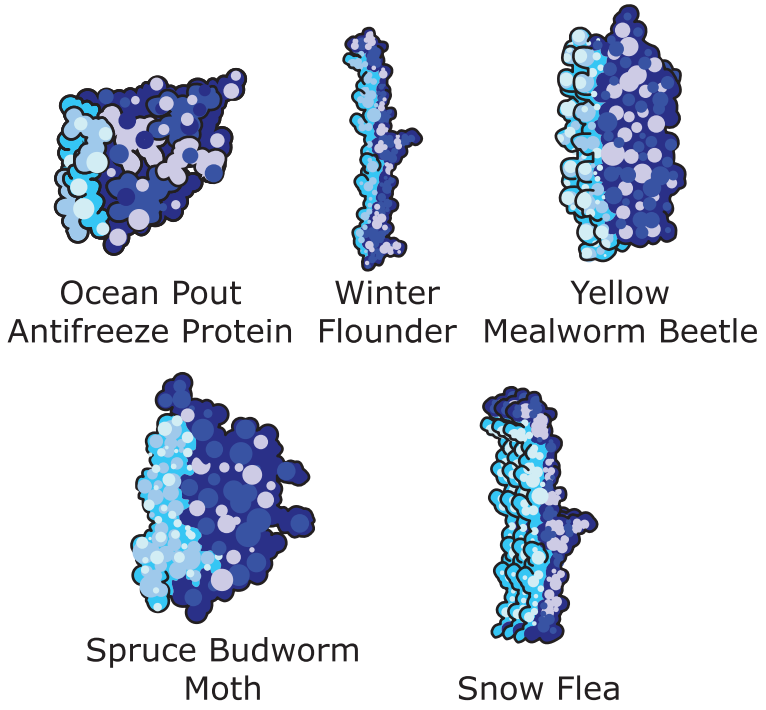
The researcher observes ocean pout surviving below the freezing temperature of water. Since the formation of ice crystals in cells destroys cell membranes, the researcher becomes interested in finding out how the ocean pout can survive such low temperatures. Follow-up work in the lab reveals that the ocean pout manufactures an "antifreeze" protein which reduces the freezing temperature of its blood and other body fluids.

Figure 2. Ocean Pout Antifreeze Protein



The active site of the protein works by attaching to ice crystals as they form and preventing them from expanding. Testing identifies the protein as AFP (type III antifreeze protein). It is similar in structure and function to antifreeze proteins found in other organisms.

Figure 3. Antifreeze Proteins of Several Organisms



Messenger RNA coding for AFP is found at high concentrations in most tissues in the ocean pout, especially those of the liver, gills, and stomach. The manufactured protein then circulates inside and between cells, protecting the ocean pout as needed. This contrasts with similar fish, in which the antifreeze proteins are only manufactured in the liver.

AFP is coded for by the gene OP5a. Sequencing of AFP reveals the following amino acid sequence at one location in the protein:

lysine–lysine–arginine–serine–glutamate

1. The information provides the best evidence for which statement about the OP5a gene?

Ⓐ The protein it codes for in warmer-water fish does not have antifreeze properties.

Ⓑ When water temperature falls low enough, it changes structure to prevent ice crystal growth.

Ⓒ It rapidly copies itself throughout the DNA of ocean pout cells when water temperatures drop.

Ⓓ It includes base pairs corresponding with the amino acid sequence lysine–lysine–arginine–serine–glutamate.

2. The differences between the various antifreeze proteins presented in the information provide evidence most strongly supporting which statement?

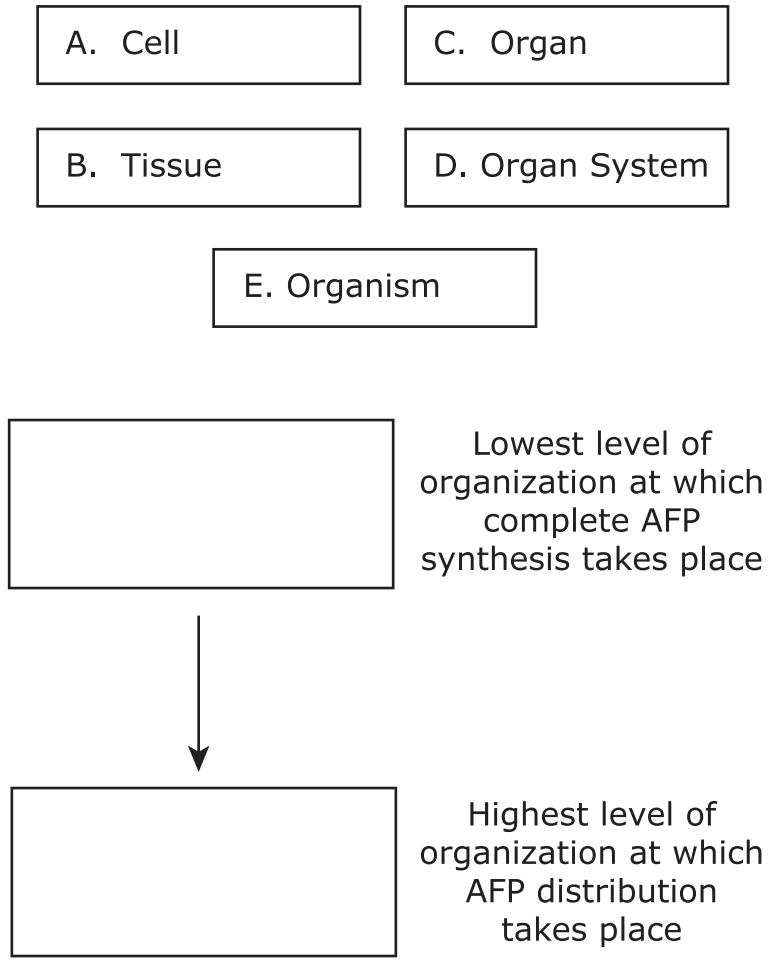
Ⓐ Each organism is exposed to different temperature ranges.

Ⓑ Each organism is exposed to a different minimum temperature.

Ⓒ The DNA which determines the structure of the protein has a distinct function in each organism.

Ⓓ The DNA which determines the structure of the protein has a distinct sequence in each organism.

3. A student is developing a diagram model of AFP synthesis in ocean pout in terms of the ocean pout's levels of organization. Write the correct answer in each box to complete the student's model.



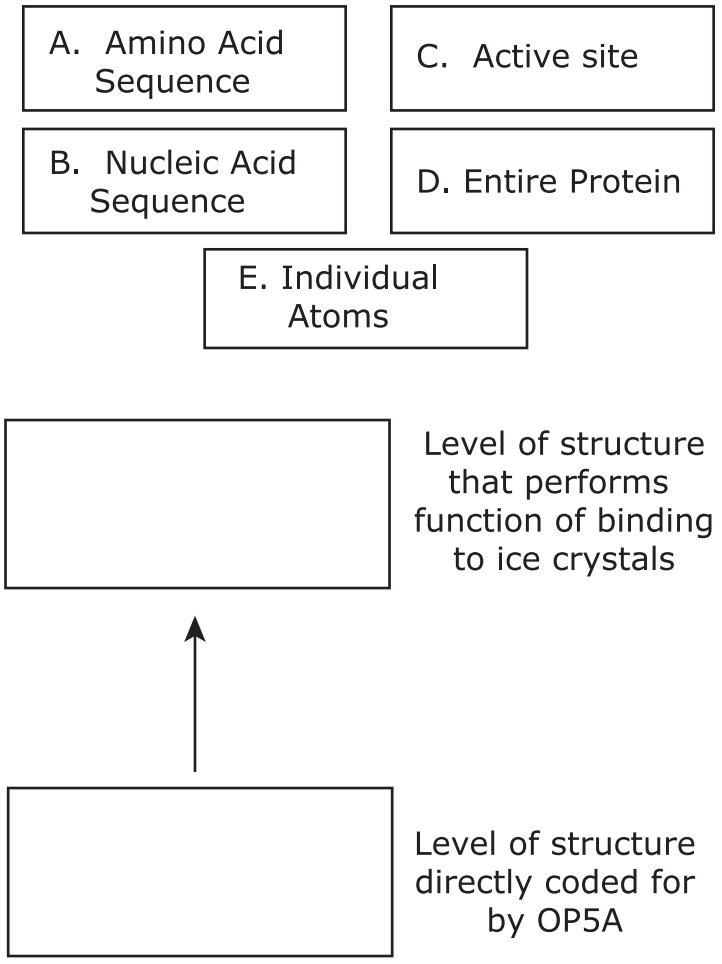
4. Consider the amino acid sequence of AFP that is presented. Write the correct answer in each box to complete the sentence.

A. base pair	B. codon	C. nucleic acid	D. lysine

E. arginine	F. serine	G. glutamate

The amino acid sequence provides evidence that the OP5a gene includes at least one sequence in which two copies of the [ ] for the amino acid [ ] appear adjacent to one another.

5. A student is creating a presentation on the levels of structure in the AFP protein. The presentation includes the diagram below. Write the correct answer in each box to relate structure to function in AFP.



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6. Reflect on the information provided about AFP synthesis and structure which is universal to all proteins, and the information that is unique to AFP to complete these tasks:

- Identify two pieces of information about AFP that are universal to all proteins.
- Identify one piece of information which is unique to AFP.
- Explain how this unique information contributes to AFP performing its function.

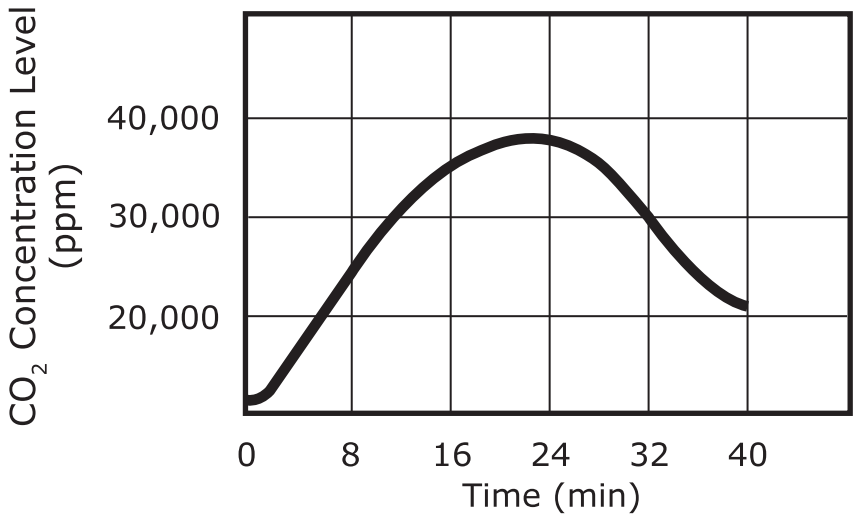
Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

A terrarium is a closed system that was made by adding gravel, sand, soil, plants, worms, insects, and snails to a glass bottle. A carbon dioxide sensor on a probe was sealed inside of the bottle as shown in Figure 1.

Figure 1. Carbon Dioxide Sensor on Probe

The mass of the plants remained constant during the experiment. The carbon dioxide data that was collected is shown in Figure 2.

Figure 2. Carbon Dioxide Concentration Level



7. How is the mass of carbon dioxide (CO_2) maintained in the terrarium?

Ⓐ Chemical elements in the outputs of respiration are rearranged as inputs of photosynthesis.

Ⓑ Chemical elements in the outputs of respiration are rearranged as outputs of photosynthesis.

Ⓒ Chemical elements needed by photosynthesis use sunlight to be converted into the outputs of respiration.

Ⓓ Chemical elements produced by photosynthesis use sunlight to be converted into the inputs of respiration.

8. Which statement best describes what is happening in the terrarium at the point that 16 minutes have elapsed?

Ⓐ The rates of both respiration and photosynthesis are increasing.

Ⓑ The rates of both respiration and photosynthesis are decreasing.

Ⓒ The rate of respiration is greater than the rate of photosynthesis.

Ⓓ The rate of photosynthesis is greater than the rate of respiration.

9. Different processes in the terrarium result in different changes to the carbon dioxide concentration. Match the process with its effect on the carbon dioxide concentration inside the terrarium.

Write the correct answer in each box. Not all answers will be used.

A. Plants respire

B. Plants photosynthesize

C. Insects respire

D. Insects photosynthesize

E. Snails respire

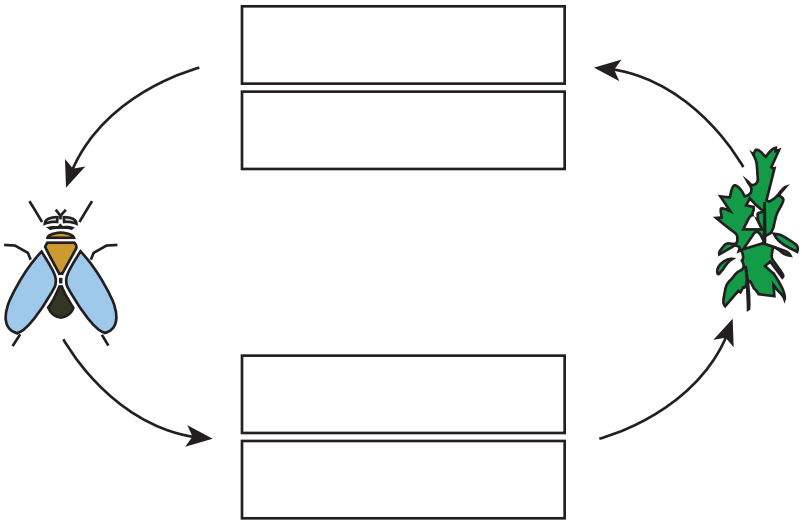
F. Snails photosynthesize

Increases carbon dioxide	**Decreases carbon dioxide**

10. The fly and the plant depend on one another for molecules from photosynthesis and respiration.

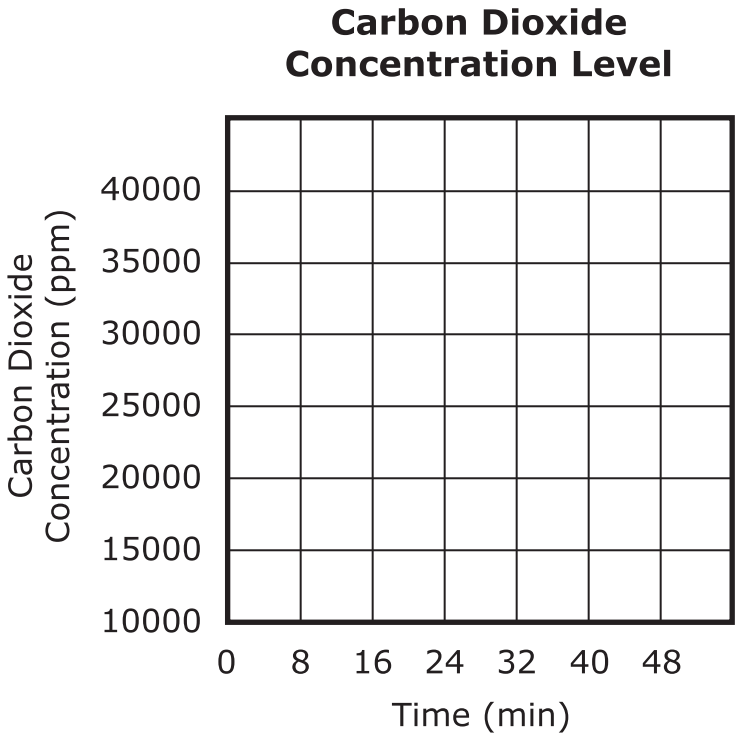
Write the correct answer in each box.

A. carbon dioxide	C. oxygen
B. glucose	D. water



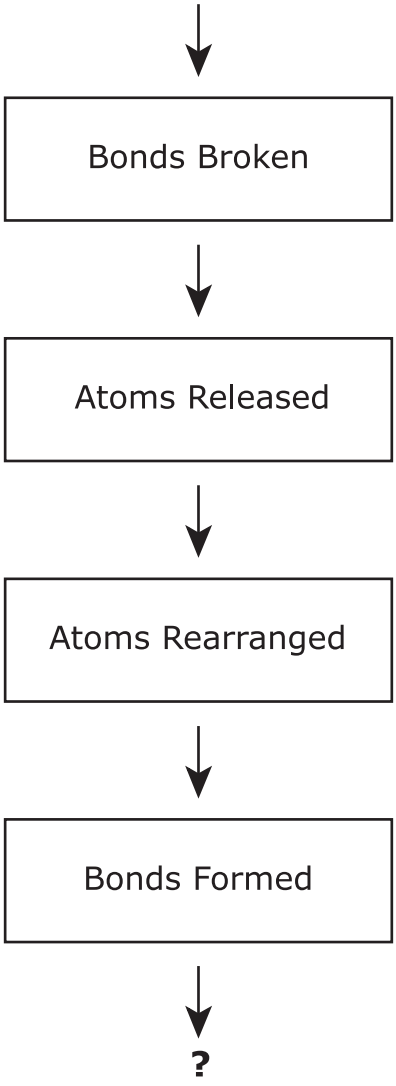
11. The gas concentrations in the terrarium will eventually reach equilibrium. Graph the approximate carbon dioxide concentrations shown in Figure 2 for 8, 16, 24, 32, and 40 minutes. Then predict the carbon dioxide concentration at 48 minutes.

Draw 6 points on the graph.



12. Food and oxygen molecules are needed by the animals in the terrarium. These molecules are rearranged in the process shown in Figure 3.

Figure 3. Food and Oxygen Molecules



Use the flowchart of the process to answer the questions.

- What energy changes occur as bonds are broken and as bonds are formed?
- As a result of the rearrangements, which molecules are formed within the animals as final outputs of the process?
- Why must animals and plants both perform this process to survive?

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

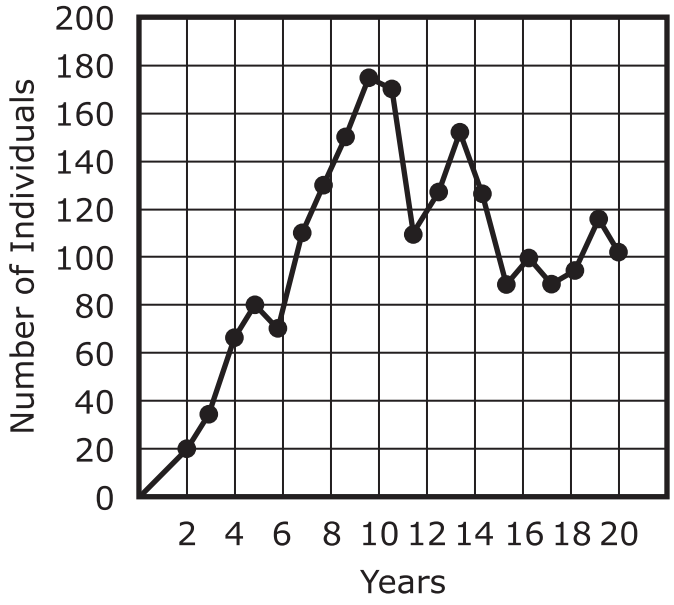
In 1995, a population of 31 gray wolves was introduced into Yellowstone National Park. The population of the gray wolves fluctuated in the 20-year period after introduction. In 2019 an estimated 80–110 wolves are present in the park.

Wolves, elk, and bison are native to Yellowstone, but the wolves disappeared in the 1920s due to excessive hunting. Wolves are primarily carnivores, and elk and bison are primarily herbivores.

GO ON ▶

A team of scientists monitored the population of wolves in Yellowstone for the first 20 years after their release.

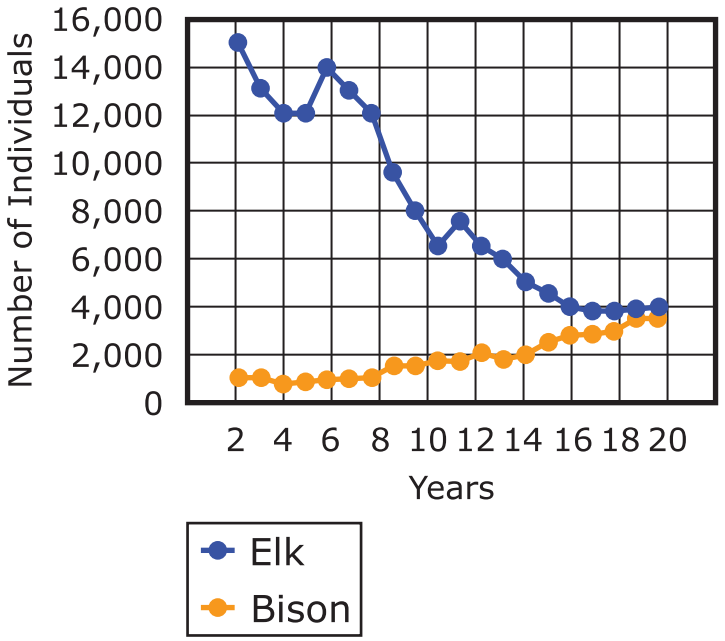
Figure 1. Number of Wolves in Yellowstone After Release



Source: NPS/Yellowstone Wolf Project

The scientists also monitored the populations of elk and bison in Yellowstone for the first 20 years after the wolves' release.

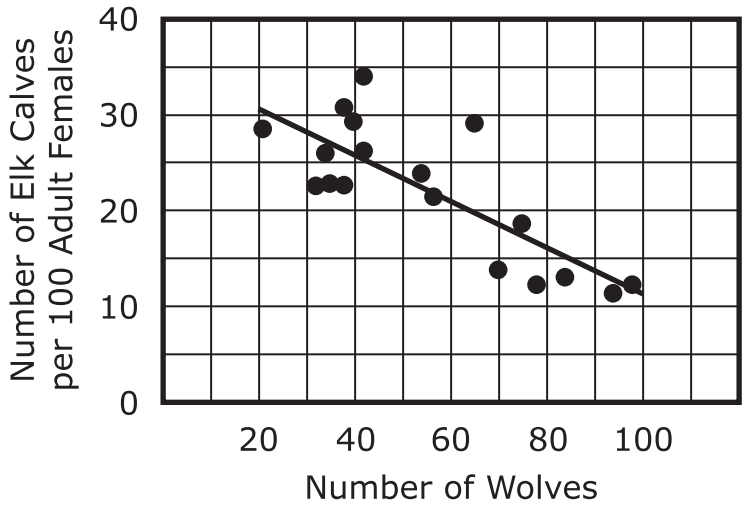
Figure 2. Number of Elk and Bison in Yellowstone After Wolf Release



Source: NPS/Yellowstone Wolf Project

The scientists also tracked the number of elk calves born per 100 elk females compared to the total number of wolves in the park.

Figure 3. Comparison of the Number of Elk Calves per 100 Elk Females to the Number of Wolves in Yellowstone



Source: NPS/Yellowstone Wolf Project

13. The formula for calculating percent change is below. Which of the following explanations about the elk population is best supported by the percent change in their population from Year 2 to Year 20? You can use the calculator to answer this question.

$$\frac{\textit{New Value} - \textit{Original value}}{\textit{Original value}} \times 100 = \%\ \textit{change}$$

Ⓐ Since the elk population experienced a 73.3% decrease, the wolves likely preyed on the elk.

Ⓑ Since the elk population experienced an approximate 26.7% decrease, the wolves likely took food resources from the elk.

Ⓒ Since the elk population experienced an approximate 400% increase, the wolves were likely a good food source for the elk.

Ⓓ Since the elk population experienced an approximate 250% increase, the wolves likely provided good resources for the elk.

14. Based on the trends in the data, which statement best explains the trends in the bison population during this 20-year period?

Ⓐ A decrease in resources for the bison caused fewer bison calves to be born.

Ⓑ An increase in predation of adult bison caused an exponential decrease in the bison population.

Ⓒ A decrease in competition from elk over resources caused the carrying capacity of bison to increase.

Ⓓ An increase in competition from wolves over resources caused the carrying capacity of bison to decrease.

15. The scientists want to use the data to explain that the wolf population in Yellowstone reached carrying capacity during the 20-year period. Write one correct answer in each box to support the explanation.

A. Years 1–9	F. Between 20–40 wolves
B. Years 4–5	G. Between 50–75 wolves
C. Years 10–12	H. Between 85–100 wolves
D. Years 15–20	I. Between 140–160 wolves
E. Did not occur during study period.	

Years of Rapid Population Growth for Wolves	**Years of Stabilization for Wolf Population**

Approximate Carrying Capacity of Wolves in Yellowstone

16. Use the data to place the descriptions that best describe the carrying capacity in elk and bison from Year 1 to Year 20. Write the correct answers in each box.

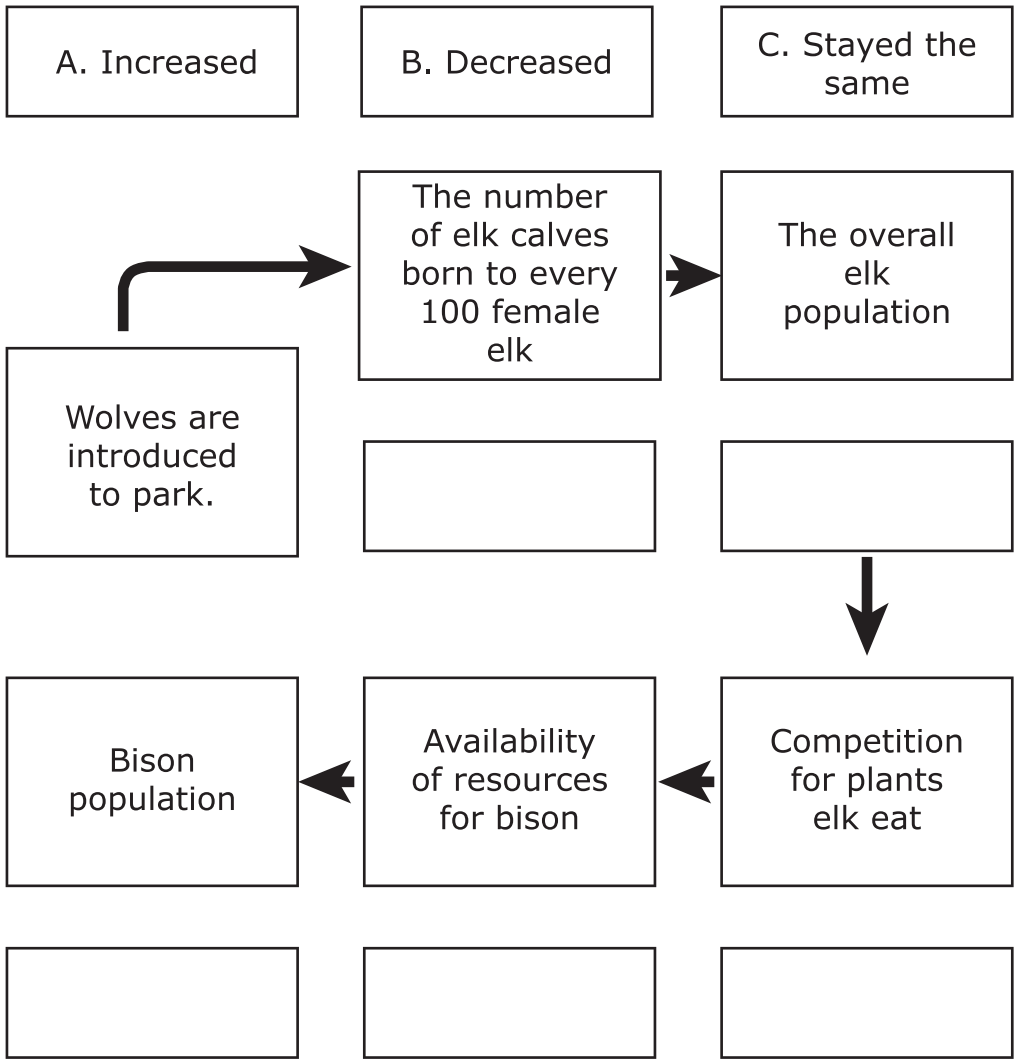
A. Did not change

B. Decreased

C. Increased

Elk Carrying Capacity	Bison Carrying Capacity

17. The scientists want to use the data to explain the relationship between the wolf introduction and the trends in the elk and bison populations. Write the correct answer in each box. Each answer may be used more than once.



18. Both elk and bison are prey for wolves, but one of these prey animals make up 89%–96% of the wolves' diet in Yellowstone.

- Use the data from the graphs to explain which prey animal most likely fits this description.
- Use the data to explain how the trends during this 20-year period likely affected the interactions between these organisms in the ecosystem. Support your explanation using data from the graphs.
- Predict what would likely happen to the ecosystem if this prey population disappeared from Yellowstone as the wolf population once did. Use the graphs to describe the effect it would have on both the wolves and the other prey population.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

GO ON ▶

STOP


STOP


STOP

Unit 2

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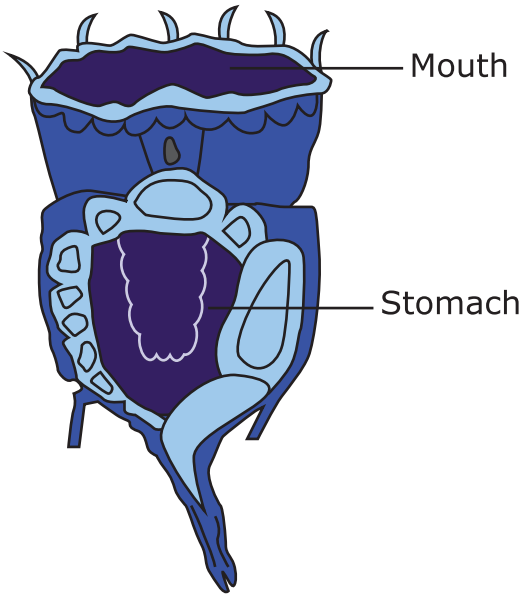
GO ON ▶

On a field trip, a student collects a sample of lake water and examines it under a microscope. The student sees a microscopic animal with a clearly visible mouth and stomach. Her teacher identifies the organism as a type of zooplankton:

Figure 1. Zooplankton



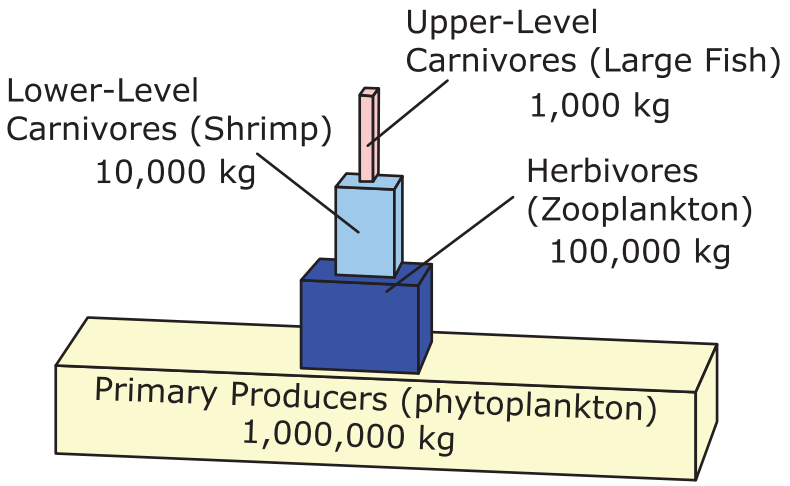
The zooplankton takes water into its mouth, which it then filters, sending tiny particles of photosynthetic algae (phytoplankton) to its stomach for digestion. The student observes the feeding activity of the zooplankton, although the particles they are consuming are so small they remain invisible under the student's microscope.

The student also observes zooplankton of varying sizes. The student cannot measure absolute size, but observes individuals within a single species ranging from a smallest observed size to three times that size. Her teacher explains that in addition to natural size variation, zooplankton get larger as they mature.

GO ON ▶

The student researches the ecological role of zooplankton and finds a simplified model of biomass at different trophic levels in ecosystems which includes zooplankton:

Figure 2. Aquatic Biomass Pyramid



19. Over a 24-hour time period, the student periodically observes the zooplankton consuming phytoplankton. The student wants to use this observation to graph the amount of energy taken in by the zooplankton over the time period. The student intends to average energy intake to produce a smooth line. Which statement best describes the line?

Ⓐ It is vertical.

Ⓑ It is horizontal.

Ⓒ It has a negative slope.

Ⓓ It has a positive slope.

20. Given the information the student collected, which statements help to explain the observed changes in maturing zooplankton body size?

Select **two** correct answers.

Ⓐ They are able to use ingested carbohydrates for growth.

Ⓑ They are able to use ingested carbohydrates for energy.

Ⓒ They use all carbohydrates for energy and all proteins to make new DNA.

Ⓓ They are able to use ingested proteins to produce carbohydrates for metabolic activity and growth.

Ⓔ They can only add to their body structure by using unchanged proteins and nucleic acids from their food.

21. The student uses the information in Figure 2 to generate an equation representing the mass of living material a trophic level can support in the trophic level above it.

The term (t) represents the mass of living material in a trophic level.

The term ($t + 1$) represents the mass of living material in the trophic level above.

Complete the student's equation below. Write the correct answer in the box.

$$(t+1) = \boxed{}(t)$$

22. The student is working on an explanation for zooplankton size change in terms of ingested phytoplankton material. The student thinks that most of the matter needed for this growth could be derived from molecules formed directly during photosynthesis in phytoplankton. The student sorts elements by the following classifications.

Place check marks in the boxes to indicate correct answers in each row.

	Carbon	**Hydrogen**	**Nitrogen**	**Oxygen**
Obtained from sources other than photosynthesis	☐	☐	☐	☐
Used to construct all protein molecules	☐	☐	☐	☐

23. The student compares photographs of zooplankton at different stages of maturation, observing that body size increases between the earliest and latest stages.

Circle the correct answer from each list to complete the sentences.

The change in body mass through growth largely comes from molecules synthesized by

zooplankton during cell division
phytoplankton during photosynthesis
phytoplankton during ATP production

.

The synthesized molecules must include additional matter from a variety of sources because this process does not produce

heat energy
carbon dioxide during respiration
all substances needed for growth

.

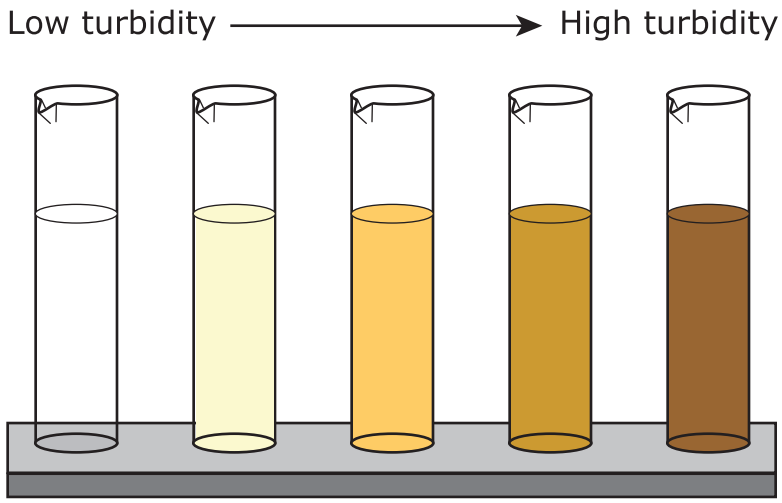
24. The student takes part in another study of the lake ecosystem. As part of this study, 250 grams of zooplankton are collected from lake water.

- Identify the approximate number of grams of phytoplankton the ecosystem must include in order to support the zooplankton sample. Explain your answer.
- Identify the approximate maximum number of grams of lower-level carnivores the sample can support. Explain your answer.
- Explain the relationship between the masses in terms of the cycling of energy in the ecosystem.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

A researcher investigating cattle in the Blue Mountains of Oregon observes the cattle drinking water from a local stream. The activity of the cattle muddies the clear water of the stream. After the cattle depart, the researcher finds that they have trampled and destroyed several fish eggs, which turn out to be from trout and salmon species listed as "threatened" under the Endangered Species Act. Salmon consume tiny animals, which in turn consume tiny producer organisms. The producers depend on sunlight passing into water so that they can perform photosynthesis.

Figure 1. Water Turbidity



25. A researcher plans to use a computer simulation to explore whether there are any procedures which would allow cattle to drink from a stream while minimizing impact on the eggs of threatened fish. In order to produce a simulation which accurately models this system, which is the most important step?

Ⓐ using as powerful a computer as possible to run the software which produces the simulation

Ⓑ developing software that uses detailed quantitative observations of the amount of mud in water

Ⓒ running simulations using as many different configurations of system parameters as the software will allow

Ⓓ preventing cattle from using the streams until the simulation has been run and a correct solution has been found

26. A researcher wants to create a computer simulation of the freshwater ecosystems of the Blue Mountain area to try to find the most effective and least costly strategy to conserve threatened fish populations. Which statement best describes the difficulty in creating a computer simulation that is useful for this situation?

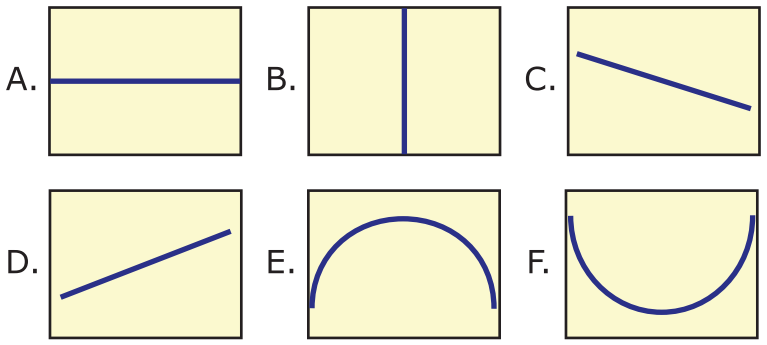
Ⓐ The available conservation strategies are expensive.

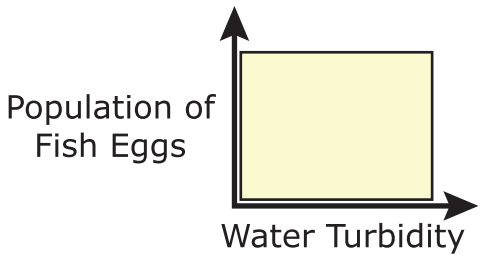
Ⓑ Cause and effect cannot be isolated outside of the laboratory setting.

Ⓒ Habitat fragmentation is extremely difficult to reverse after it has taken place.

Ⓓ A wide variety of human causes contributes to a narrow range of fish population effects.

27. Turbidity is a measure of the cloudiness of water due to the presence of tiny particles in the water. A researcher is working on a simulation of the impact of reducing water turbidity on threatened salmon populations. Based on the food chain information, the simulation should most likely generate which data line? Write the correct answer on the graph.





28. A researcher is working on a simulation to test the impact of a program of collecting and incubating threatened fish eggs and releasing them as young fish back into the environment. The simulation will be created to investigate whether the program successfully reduces the impact of cattle. It will also investigate the economic impacts of the program.

To perform its functions, the simulation should be created to include the following. Write the correct answer in each box.

A. the proportion of eggs hatched under this program that are expected to survive

B. the proportion of fish produced under this program that are eaten by predators

C. the cost per fish of implementing this program relative to others

D. whether cattle or fish are of greater economic value

E. the lowest cost way to implement program procedures

Investigate whether the program successfully reduced the impact of cattle ranching: predict

Investigate whether the program is economical: predict

29. The student uses a simulation to compare solutions to the problem of cattle damaging fish eggs. Order the steps in the procedure to produce a successful development and implementation cycle.

Write the correct answer in each box.

A. Refine the design and simulation.

B. Compare predicted and real design outcomes.

C. Simulate changes in conditions based on the design.

D. Implement the design in a test area.

E. Construct simulation of existing conditions in a representative area.

F. Collect initial data on real conditions.

Step	Procedure
1.	
2.	
3.	
4.	
5.	
6.	

GO ON TO NEXT PAGE

30. A student is designing a computer simulation to explore the impact of varying levels of cattle presence at a stream in the Blue Mountain area on threatened salmon population size over periods spanning multiple generations of salmon.

- Identify all input variables and output variables of the simulation.
- Describe how the simulation will account for the biodiversity from generation to generation.
- Describe, citing specific details, how this simulation is limited compared with the real system being simulated.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

It has been observed that the heights of Wisconsin Fast Plants vary within a population. Fast Plants are a specially bred type of *Brassica rapa* plant which grow very quickly, reaching maturity in 5 weeks instead of 6 months. They reproduce sexually.

A student orders Fast Plant seeds to perform a science investigation. The student grows 24 plants, and measures their heights 14 days after planting. The information is summarized in Table 1.

Table 1. Plant Heights After 14 Days (in centimeters)

14	6	15	14	13	28	15	17
13	5	12	15	15	16	15	14
31	15	16	15	12	30	14	15

Height in Fast Plants is determined by the genes *EIN* and *ROS*. A mutation of one of these genes will produce a plant with an unusual height. Fast Plants expressing the recessive allele *ein* grow taller than usual. Fast Plants expressing the recessive allele *ros* grow shorter than usual.

31. Examining which property of the data set allows identification of individuals who are homozygous for recessive height traits?

Ⓐ mean

Ⓑ range

Ⓒ median

Ⓓ outliers

32. A student claims that meiosis can result in Fast Plants with the rare gene combination of two copies of the *ein* gene. The plant with which height in the table provides evidence supporting this claim?

Ⓐ 5 cm

Ⓑ 12 cm

Ⓒ 15 cm

Ⓓ 30 cm

33. Find the percent of plants in the student's experiment that are homozygous for *ein* or *ros.* You can use the calculator to answer this question. Round the answer to the nearest percent. Write the correct answer in the box.

[ ] %

34. The student crosses plant A, which has a height of 14 cm, with plant B, which has a height of 15 cm. Most of the offspring are normal height and the others are short.

The student claims that crossing plant A and plant C, which has a height of 6 cm, can only produce offspring with normal or short phenotypes. Find evidence that supports the student's claim. Write the correct answer in each box.

A. ROS/ROS	B. ROS/ros	C. ros/ros

D. natural selection

E. environmentally-induced mutation

F. genetic recombination

Plant A must have the genotype

[ ] and

plant C must have the genotype

[ ] .

During reproduction of Plant A and plant C, the

process of [ ]

can result in offspring with normal or short

phenotypes.

35. The student's experiment was designed to isolate causes of plant height. Write the correct answer in each box.

A. genetically identical	B. identical in phenotype	
C. raised under identical conditions		
D. genetics	E. mutations	F. the environment

In order to produce this outcome, the plants had to be

[ ] , so that the role of

[ ] in causing variations in plant growth

would be minimized.

36. A group of Fast Plants with the same mix of height genes is grown on a plot of land with abundant soil nutrients, water, and light. The plot of land is exposed to a bird species that preys on tall plants.

- Based only on this description of the environment, what is the most likely survival rate of plants in the first generation? Explain. You can use the calculator to help answer this question.
- Why would plants with a trait that is detrimental in this environment continue to appear in offspring of surviving plants?
- How would the incidence of the detrimental trait change over time? Explain.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

STOP


STOP


STOP

Unit 3

Welcome! Today you will take unit 3 of the DC Science Assessment Practice Test.

To respond to the tasks on this test, you may be asked to review information in the form of text, images, data tables, and graphs. Analyze all the information and tasks carefully and then respond to each task. You may need to read across multiple pages to see all the information. You will be allowed to use a calculator for all units in this test.

Some tasks require more than one response. You may look back at the information as often as necessary.

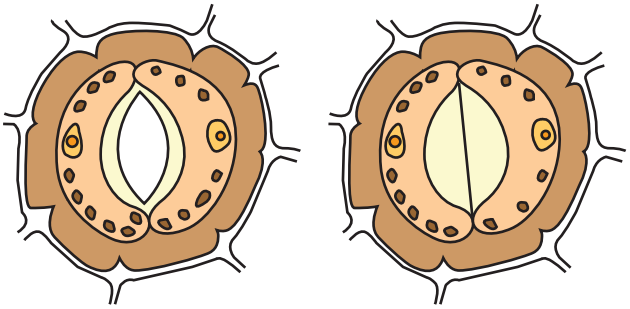
For tasks that ask you to explain, describe, or answer in your own words, write your responses in the space provided. You may use scratch paper to organize your thinking before writing your response in the space provided.

For tasks that ask you to fill in the blank spaces or write answers in the correct box, you may write the letter corresponding to the response or write the entire response in the blank space.

If you are unsure about an answer, select or compose an answer you think is the best response. You can always go back to the items you are unsure of after you've answered all other questions in the unit.

A student uses a light microscope to examine the leaf of a tomato plant. She observes that tiny openings in the plant leaves open and close under different light conditions. These openings are called stomata (singular: stoma).

Figure 1. Stomata



An Open Stoma A Closed Stoma

GO ON ▶

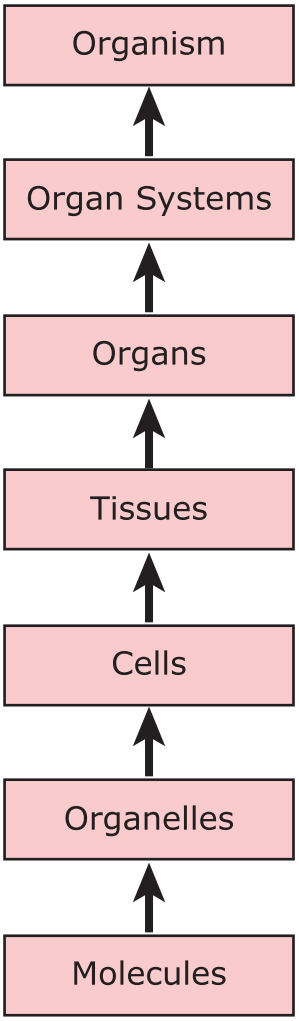
The student decides to design an experiment exploring how stomata open and close in a tomato plant in response to stimuli. The results will allow the student to model the relationship of stomata to homeostasis in the plant overall. The student exposed the plants to different amounts of light and humidity for a period of 30 minutes and then made observations. The students' summary of the experimental results are shown in the table.

Table 1. Experimental Results

Experimental Condition		Stomata State
Brightness	**Humidity**	**Results**
Very bright	Humid	Open
Very bright	Dry	Closed
Ordinary brightness	Very humid	Open
Ordinary brightness	Very dry	Closed
No light - dark	Humid	Closed
No light - dark	Dry	Closed

GO ON ▶

Figure 2. Levels of Organization in the Student's Model



37. In a plant, when the turgor pressure is low, the stomata close and the leaves wilt. When the turgor pressure is high, the stomata open and the leaves are firm. Based on the data in Table 1, under which conditions would the leaf stay firm?

Ⓐ Ordinary brightness, very humid

Ⓑ Ordinary brightness, very dry

Ⓒ No light - dark, humid

Ⓓ No light - dark, dry

38. The student plans to use the results of the investigation to further study stomata. The student builds a model to demonstrate stomata structure and function at the lowest level of biological organization. Investigating which question would require a model that is designed to this level?

Ⓐ How do the cells surrounding stomata respond to environmental stimuli?

Ⓑ How does the opening and closing of stomata affect other tissues in a leaf?

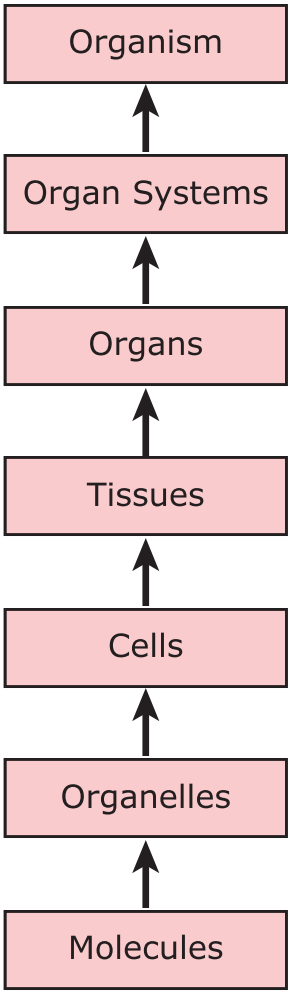
Ⓒ What effect do stomata have on survival of the plant when they are closed for long periods of time?

Ⓓ How do stomata affect the transport of water through plant organs when they respond to different levels of humidity?

39. The student incorporates the layer of the leaf where stomata are present into a model of overall leaf function. Use the images of the stoma to determine the correct level of biological organization at which this layer should be classified.

Circle the correct answer.

Levels of Organization in the Student's Model



GO ON ▶

40. The student designs a second investigation based on the results of the first investigation. In the second investigation, she will try to determine whether conserving water or being able to photosynthesize is the higher priority in homeostatic regulation by stomata.

Circle the correct answer from each list to complete the sentences.

In her investigation, humidity and

plant species
rate of oxygen release from plant
how many stomata grow on a leaf
whether stomata are open or closed
oxygen content of air
carbon dioxide content of air

will be independent variables,

and

plant species
rate of oxygen release from plant
how many stomata grow on a leaf
whether stomata are open or closed
oxygen content of air

will be the dependent variable.

41. The student is conceptually modeling stomata in terms of their function.

Write the correct answer in each box.

A. light	B. carbohydrates	C. water vapor
D. change	E. as a one-way valve	F. as a two-way gate
G. as a producer of the matter or energy flowing through it		
H. as a consumer of the matter or energy flowing through it		

A stoma operates on the flow of [ ]

into and out of the leaf by acting [ ].

GO ON TO NEXT PAGE

42. The student studies the data table and decides to design a second investigation in which soil moisture will be an independent variable.

- Describe what can be learned based on the data table.
- Design an experiment in which soil moisture is the independent variable.
- Predict the results from this experiment over time. Explain your answer.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

Wild sheep on California's Santa Cruz Island were originally brought to the island by humans. Researchers spent several years studying the environmental impact of the wild sheep population on the island. They found that as the sheep population increased, the sheep overgrazed and trampled native plant species, resulting in multiple ecological and physical changes. Plant growth was slowed or prevented and bare ground patches appeared. Plant growth was compared with sheep population density, yielding the data in Table 1.

Table 1. Impact of Sheep Population Density on Plant Growth

Sheep Population Density (individuals per hectare)	Sheep Impact on Plant Growth	Percent of Area Impacted
0.2	light	47
0.9	moderate	36
2.1	severe	17

Source: D. Van Vuren & B. E. Coblentz, *Biological Conservation*, 1987

GO ON ▶

In areas with light impact, shrubs and grasses were largely undisturbed, though there were a few small areas of bare soil. In areas with moderate impact, there was some evidence of consumption of shrubs and grasses, some areas of bare soil, and in places sheep traffic had worn trails through vegetation. In areas with severe impact, most accessible vegetation was consumed, there were extensive bare soil areas, and sheep trails that exposed rock were not uncommon. In the bare patches, erosion accelerated, resulting in the formation of steep inclines. The amount of erosion, as characterized by ground properties, is given in Table 2.

Table 2. Relationship between Sheep Impact on Plant Growth and Ground Properties

Sheep Impact on Plant Growth	Plant Cover (%)	Bare Dirt (%)	Exposed Bedrock (%)
light	90	9	1
moderate	75	22	3
severe	60	35	5

Source: D. Van Vuren & B. E. Coblentz, *Biological Conservation*, 1987

GO ON ▶

After the introduction of sheep, native bird populations showed a loss of density and diversity.

Table 3. Relationship between Sheep Impact on Plant Growth and Bird Populations

Sheep Impact on Plant Growth	Bird Density (number of birds per square kilometer)	Bird Diversity (number of species present)
light	506	17
moderate	214	8

Source: D. Van Vuren & B. E. Coblentz, *Biological Conservation*, 1987

43. A scientist claims that sheep activities are impacting the entire food web of Santa Cruz Island. Which statement best evaluates this claim?

Ⓐ The claim is not valid because diverse plants and birds are still found on the island.

Ⓑ The claim is not valid because the sheep population is unevenly distributed over the island.

Ⓒ The claim is valid because the bird diversity decreases as the plant growth impact increases.

Ⓓ The claim is valid because plant growth is most impacted in areas with high sheep population densities.

44. A scientist claims that once sheep are present, exact sheep population density has little impact on an ecosystem. Which statement best uses the data provided to evaluate this claim?

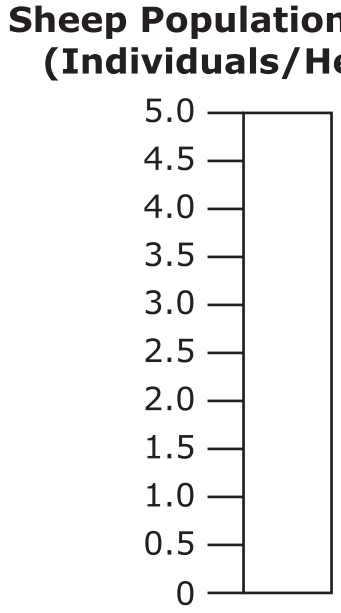
Ⓐ The claim is valid because the sheep population is limited by the carrying capacity of the existing island ecosystem.

Ⓑ The claim is not valid because once sheep are introduced to an area it is inevitable that its ecosystem will radically change.

Ⓒ The claim is valid because some elements of the existing ecosystem survive all levels of sheep population density on the island.

Ⓓ The claim is not valid because small changes in sheep population density lead to very different outcomes in terms of plant growth impact.

45. One policy planner would like to maintain a sheep population on Santa Cruz Island, but at a density low enough that sheep will show less than moderate impact on plant growth. Which is the highest population density acceptable under this plan? Shade in the bar to the correct height.



46. Write the correct answer in each box.

First Blank

A. planting seeds and placing artificial turf on the island.

B. introducing new organisms that compete with birds.

C. reducing and controlling the size of sheep populations.

Second Blank

D. a static state once forces for change are removed.

E. stability because forces for change are removed.

F. a constant rate of degradation.

A student is interning with a conservation group that seeks to restore the size and diversity of bird populations on Santa Cruz Island. The student designs a plan of

[ ]

The student explains that when this solution is implemented, the ecosystem overall can be expected to show

[ ]

47. One conservation plan for the island proposes reducing sheep population density to 1.5 individuals per hectare in all areas where it is above 1.5. Write the correct answer in each box.

First Blank

A. be beneficial

B. lack benefit

Second Blank

C. 58%

D. 68%

E. 78%

Third Blank

F. light and moderate

G. moderate and severe

Based on the evidence in Tables 1 and 2, this solution would [ ] because the predicted plant cover would be approximately [ ].

This would would represent a sheep impact on plant growth with a status between [ ].

48. A scientist argues that changes produced by the sheep are destabilizing the current ecosystem on Santa Cruz Island, leading to formation of a new type of ecosystem.

- Identify two pieces of data from Table 2 that provide evidence that sheep are significantly changing the physical landscape of the island.
- Based on the data, describe the process that changes the physical landscape.
- Evaluate whether the scientist's argument is valid. Explain your evaluation.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

GO ON ▶

Scientists have observed a decrease in dissolved oxygen levels and a decrease in the level of light in the water in a pond. This seems to be happening because the water is cloudy. They conducted two experiments to test the responses of a local species of pondweed (an aquatic plant) to these changing conditions.

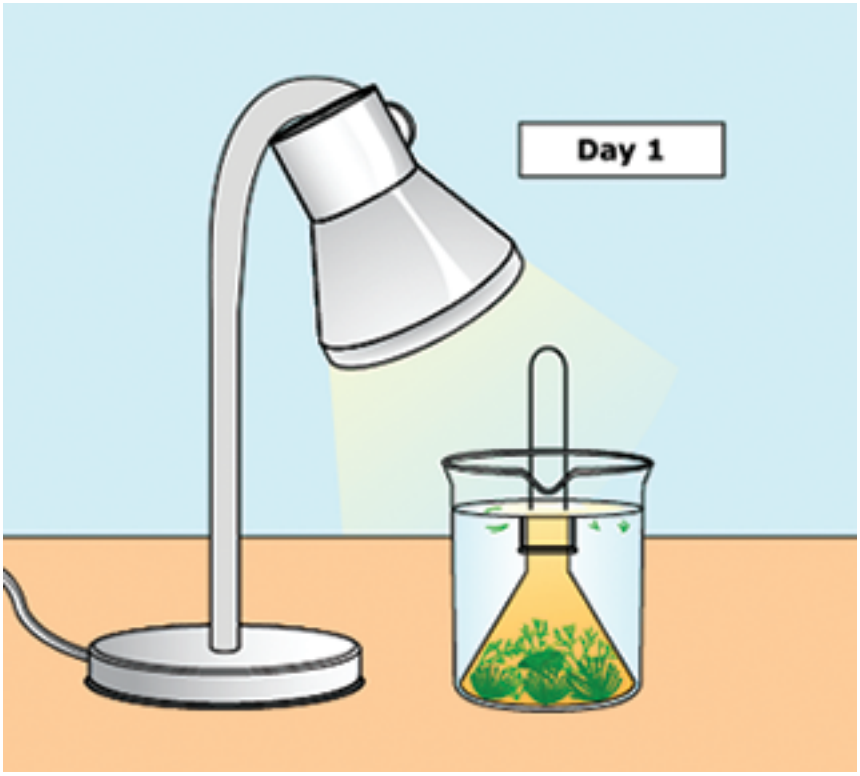
Experiment 1: The first part of the experiment measured the effects of light intensity on carbon dioxide absorption and release in pondweed. Two groups of pondweed were submerged in water. One group was put in light, and the other was kept in darkness. The presence of carbon dioxide in water can be detected with a pH indicator called phenol red. Table 1 shows how the color of phenol red changes due to pH.

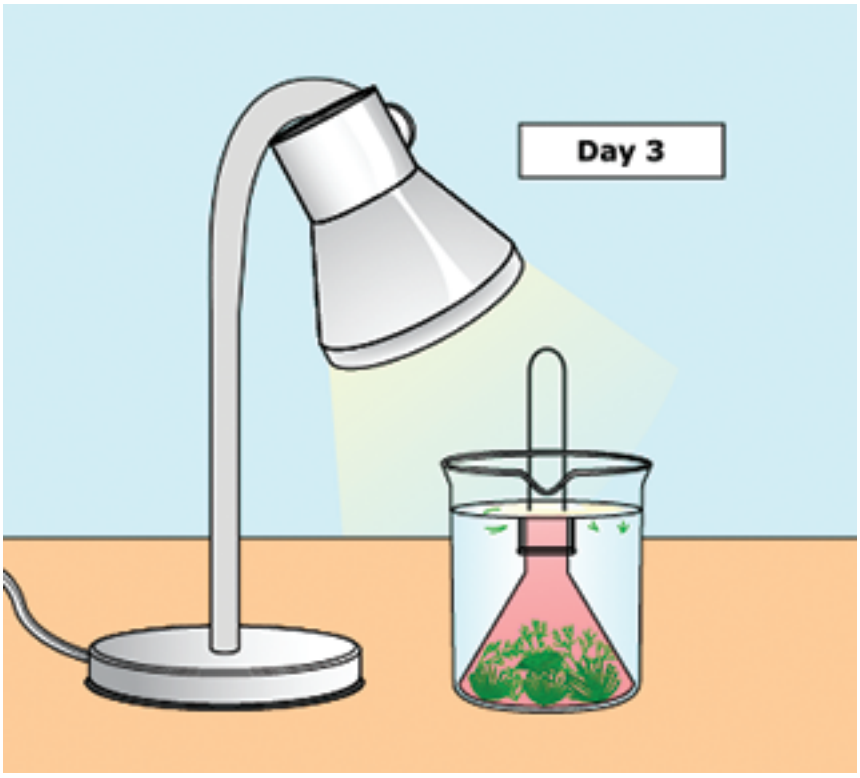
Table 1. Color of Phenol Red with pH Changes

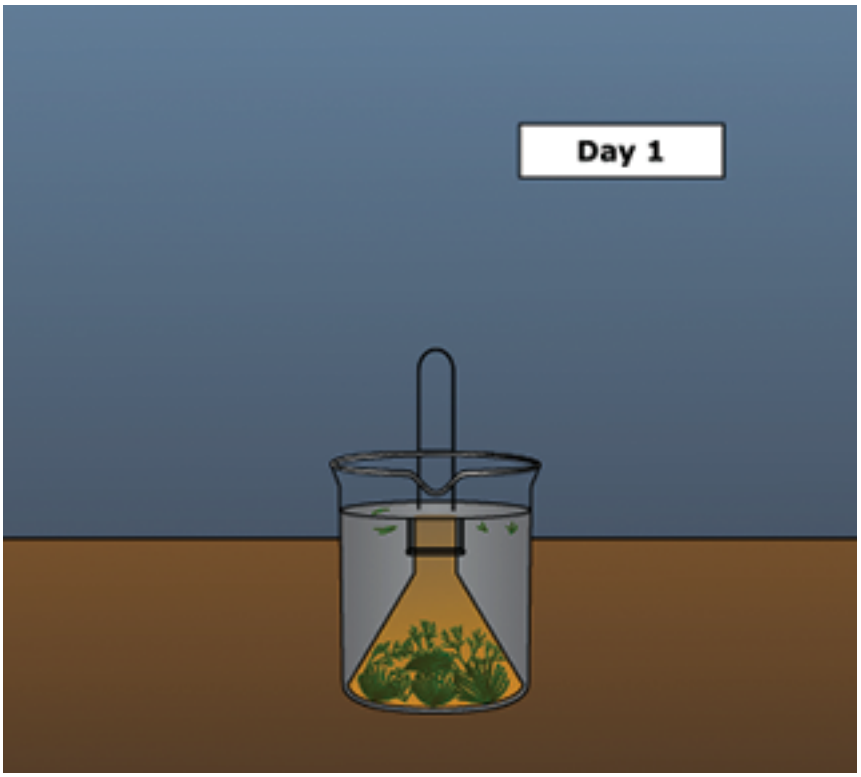
pH	Color of Phenol Red
less than 6.8	yellow
6.8–8.2	orange
greater than 8.2	pink

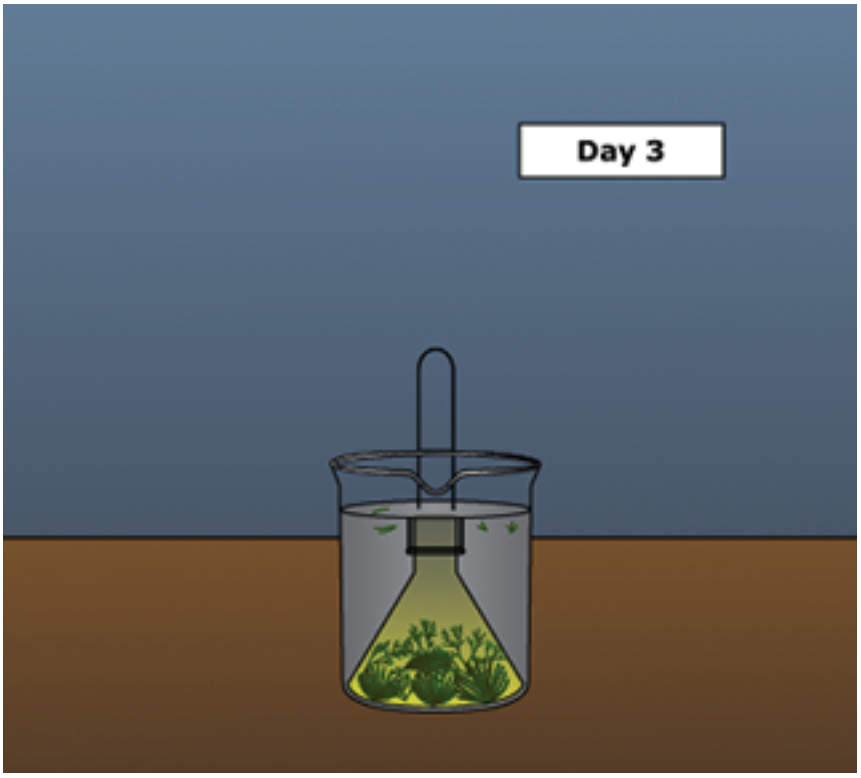
At the start of the experiment, the water with the phenol red was orange for both groups. After several days, the water of the group in light turned pink and the water of the group in the dark turned yellow.

GO ON ▶


Day 1

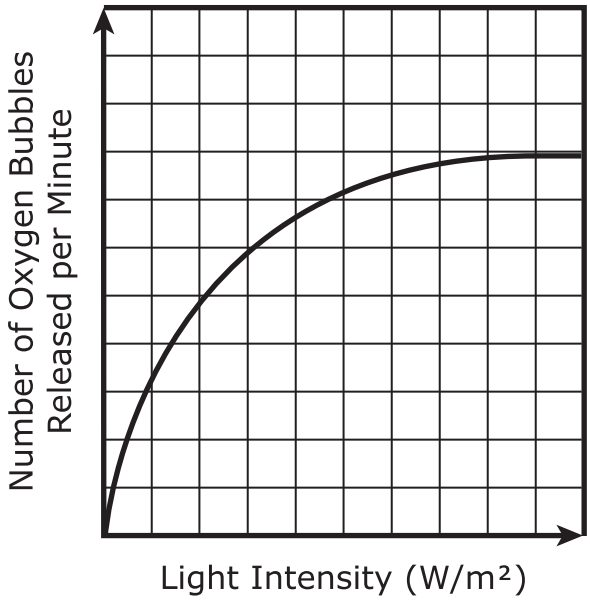

Day 3


Day 1


Day 3

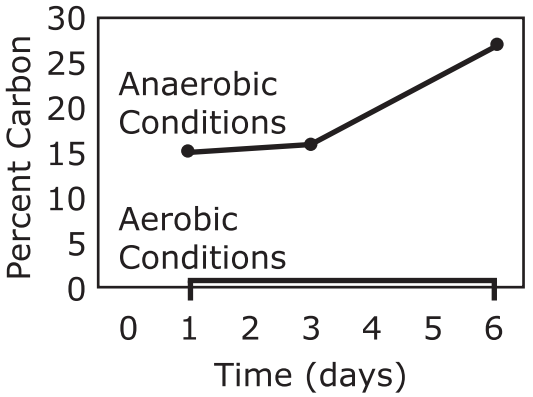
The second part of the experiment tested the effects of light intensity on oxygen release in pondweed. Oxygen release was measured by the formation of bubbles on the surface of the leaves. The results are shown in Figure 1.

Figure 1. Effects of Light Intensity on Oxygen Release



Experiment 2: The scientists had observed that under certain conditions, this species of pondweed can break down stored starch in their stems into ethanol, lactate, and energy. Two groups of pondweed were submerged in water and placed in darkness. One group had dissolved oxygen in the environment, and the other did not. For six days, the scientists measured the percentage of carbon in the plant tissues that was used to make ethanol. The results of this study are given in Figure 2.

Figure 2. Percent of Carbon Over Time



Source: T. Sato, et al., *Journal of Experimental Botany*, 2002

49. Based on the data from Experiment 1, which statement best explains how light intensity affects pondweed's ability to produce energy for life processes?

Ⓐ Energy production is constant across all sunlight intensities.

Ⓑ There is no clear link between sunlight intensity and energy production.

Ⓒ There is a maximum sunlight intensity above which energy production no longer increases.

Ⓓ There is a minimum sunlight intensity below which the energy production becomes small but constant.

50. Which statement best explains how the data in Experiment 2 relates to the availability of energy for life processes?

Ⓐ Pondweed fails to produce energy for life processes when oxygen is absent.

Ⓑ Pondweed produces more energy in anaerobic conditions than in aerobic conditions.

Ⓒ Pondweed uses different sources of matter to produce energy in aerobic and anaerobic processes.

Ⓓ Pondweed stores energy for life processes in molecules other than ethanol when oxygen is present.

51. The point where the curve on the graph levels off with a constant number of bubbles per minute is (125, 105). Complete the explanation about the availability of oxygen for life processes in Experiment 1. Write the correct answer in the box.

Based on the experimental results, exposing the same pondweed plant to a light intensity of 250 W/m^2 should result in a rate of release of [ ] oxygen bubbles per minute.

GO ON ▶

52. Complete the explanation about the cycling of matter and energy in Experiment 2. Write the correct answer in each box. Not all answers will be used.

- A. matter
- B. photosynthesis
- C. energy from the sun
- D. aerobic respiration
- E. anaerobic respiration
- F. does not produce energy
- G. produces energy in a different way

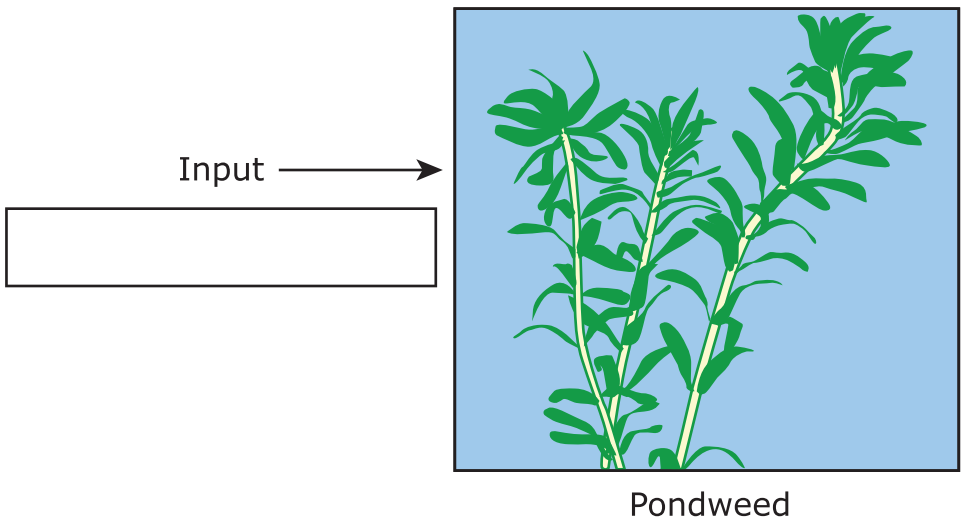
In the pond, [ ] drives the cycling of [ ] that is needed to sustain life processes. Pondweed produces the carbon-based molecule glucose through [ ] and glucose reacts with oxygen to form energy during [ ]. In the absence of oxygen, pondweed [ ], which is evidenced by the differences in percentages of carbon in ethanol between the two groups of plants.

GO ON ▶

53. A student is working on a model to explain what processes are taking place in the pondweed when the phenol red turns from orange to yellow. The student decides which substance is the input, and what process is occurring. Write the correct answer in each box of the model.

A. Photosynthesis	E. Oxygen
B. Anaerobic Respiration	F. Carbon Dioxide
C. Aerobic Respiration	G. Hydrogen
D. Protein Synthesis	H. Nitrogen

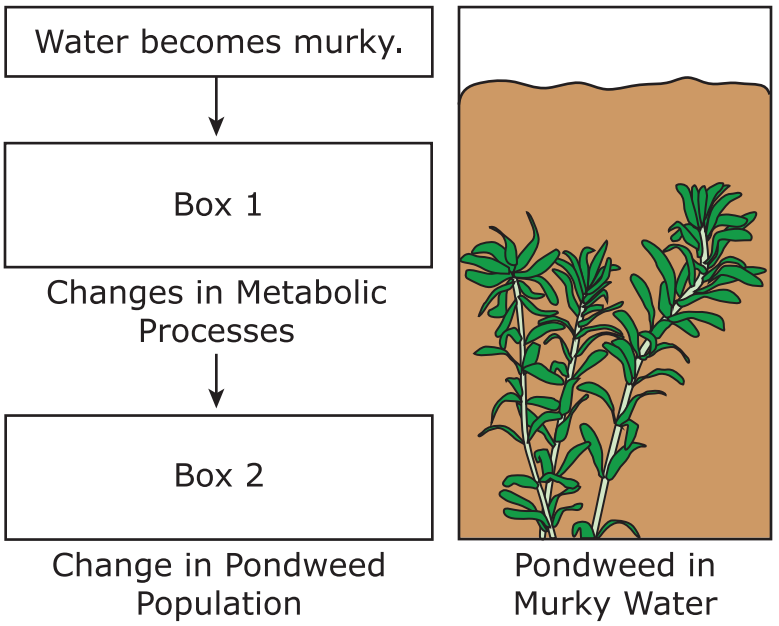
Process



Pondweed

54. Eutrophication most commonly occurs when nutrients from fertilizers enter the pond water by surface runoff. A student reads that under eutrophic conditions, water in a pond becomes murky and oxygen-deprived. The student uses the experimental data to model the effects of these conditions on pondweed growing in the pond.

Figure 3. Student's Model



- Write a description about what is happening to photosynthesis in Box 1.
- Explain what is happening with the pondweed population in Box 2 and why.
- Explain how the contents of Boxes 1 and 2 affect carbon cycling in the pond ecosystem.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

STOP


STOP


STOP

Unit 4

Welcome! Today you will take unit 4 of the DC Science Assessment Practice Test.

To respond to the tasks on this test, you may be asked to review information in the form of text, images, data tables, and graphs. Analyze all the information and tasks carefully and then respond to each task. You may need to read across multiple pages to see all the information. You will be allowed to use a calculator for all units in this test.

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If you are unsure about an answer, select or compose an answer you think is the best response. You can always go back to the items you are unsure of after you've answered all other questions in the unit.

Humans have a close working relationship with horses. As a result, many horse disorders have been thoroughly researched. A student serves a summer internship at a veterinary office specializing in horses. Over the course of the summer, the student observes horses with the following symptoms:

Horse 1: female – smaller than average body size

Horse 2: female – third pregnancy failure

Horse 3: male infant – multiple infections

The table summarizes the information.

Table 1. Summary of Observations of Horses

Horse	Symptoms	Occurs in Families?	Disorder
1	Small body size, reproductive system not fully developed	No	Equine Turner Syndrome (ETS)
2	Pregnancy failure	No	Repeated Early Embryonic Loss (REEL)
3	Immune system failure, lack of white blood cells	Yes	Severe Combined Immunodeficiency (SCID)

55. Using the data in Table 1 about SCID, which question would best guide further research?

Ⓐ Which gene or genes cause it?

Ⓑ Was it inherited from other species?

Ⓒ Is it acquired from the environment?

Ⓓ How does it provide a survival benefit?

GO ON ▶

56. Although REEL does not occur in families, it does have a genetic basis, and transcription and translation are affected. Given its genetic basis, which question could best guide further research into the causes of its symptoms?

Ⓐ Why do only female horses develop it?

Ⓑ Does it ever occur more than once in the same family?

Ⓒ What is its effect on proteins manufactured in a horse's cells?

Ⓓ Do any existing treatments allow horses with the disorder to reproduce?

57. Describe the relationship between the microscopic causes and symptoms of SCID.

Write the correct answer in each box.

A. Change in the nucleotide sequence of DNA

B. Change in the triplet mRNA code

C. Change in the protein produced

D. Change in the components of cell membrane

E. Decrease in immune system function

F. Nervous system performs immune system functions

Cause at Microscopic Level	**Effect at Microscopic Level**

Symptom

GO ON ▶

58. Write the correct answer in each box.

First Blank	Second Blank
A. mitosis	E. ATP
B. meiosis	F. RNA
C. ATP production	G. membranes
D. cell membrane formation	H. zygotes

The student concludes that the disorder of Horse 1 must result from errors in [ ]. The effect of these errors is to cause problems with newly formed [ ], which can be concluded based on the fact that horses with this disorder cannot produce offspring.

59. The student researches another horse disorder. She reads that the disorder affects the structure of one protein. The second disorder also runs in families. Similar to SCID, the disorder must be inherited from both parents, neither of whom shows symptoms of the disorder.

Write the correct answer in each box.

First Blank

- A. caused by a virus
- B. an inherited condition
- C. caused by a bacterial infection

Second Blank

- D. 2
- E. 4

Third Blank

- F. copies of a gene
- G. copies of a protein

The student argues that this horse disorder is similar to SCID in that it is [ ], and also because it requires [ ] [ ] in order to produce symptoms.

GO ON ▶

GO ON TO NEXT PAGE

60. The student considers the information on SCID given in the table. She does more research and finds that horses with SCID do not survive to adulthood. Use all the information to:

- Explain, at the chromosomal level, how SCID originally appeared in horses.
- Explain why it appears repeatedly in families.
- Explain why it hasn't disappeared in horse populations.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

GO ON ▶

Chaetognaths, or "arrow worms," are a phylum of predatory marine worms. A research station compares two closely related chaetognaths, *Sagitta elegans* and *Sagitta setosa*, which live in the same geographical area but at different water depths.

Sagitta setosa lives closer to the surface and has access to a higher density of prey organisms, but its prey organisms have small sizes. It cannot eat prey organisms over a certain size because *Sagitta* worms swallow their prey whole, and the mouth of *Sagitta setosa* is, like its body size, small.

Sagitta elegans lives in deeper water and consumes fewer organisms, but its prey organisms have larger sizes. Each species is found in the habitat of the other, but cluster mainly at their own depths.

In 24 hours, *Sagitta elegans* consumes an average of 439 prey, while *Sagitta setosa* consumes an average of 1,213 prey. Information about these two species is summarized in Table 1.

Table 1. Comparison of Sagitta Species

Organism	Depth of primary habitat (meters)	Median body length (mm)
Sagitta elegans	20+	24
Sagitta setosa	0-20	7

61. Which explanation is supported by the evidence that these two worms have a common evolutionary ancestor?

Ⓐ Longer chaetognaths live at deeper depths.

Ⓑ Diets consist of different sizes and amounts of prey.

Ⓒ The two chaetognath types have undergone speciation.

Ⓓ The two chaetognaths live in the same area but at different depths.

62. Which statement explains the factor that is most likely keeping *Sagitta elegans* from further increasing in median body length?

Ⓐ No prey organisms of a larger body size exist.

Ⓑ No genes exist in the worm species for a longer body length.

Ⓒ Insufficient prey organisms exist to support a longer worm body length.

Ⓓ No worm predators are providing a selection pressure favoring longer body lengths.

GO ON ▶

63. Both species of worm are found at all depths, though the species have preferred depth ranges. Use the data to evaluate the merits of the argument that chaetognath populations would change if the waters from various depths mixed. Write the correct answer in each box.

First Blank

- A. parasite
- B. prey
- C. predator

Second Blank

- D. sensitive to temperature
- E. tolerant to temperature changes

Third Blank

- F. do not maintain
- G. maintain
- H. thrive and increase

High winds result in temperature mixing of water. Because

Chaetognath [ ] populations are

[ ], the Chaetognaths

[ ] their current population sizes.

64. A researcher proposes a model in which *Sagitta setosa* populations fall while their body lengths increase, gradually leading to formation of a new species. Evaluate the evidence provided for past changes in chaetognaths to complete this model. Write the correct answer in each box to show the order in which the events occur.

A. A new species emerges.

B. Prey populations increase in body size but decrease in number.

C. Genes for longer body lengths spread through successive worm generations.

D. Individuals with larger mouths show an increased probability of survival.

1.
2.
3.
4.

65. A chaetognath is found living at a depth of 5 meters below the water surface. It has a body length of 22 mm. What approximate number of prey would it need to eat per day to have a higher than average chance of passing its genes on to the next generation and what evidence supports that explanation? Write the correct answer in each box.

A. more than 1213

B. less than 1213

C. less than 439

D. larger worm consumes smaller

E. larger worm consumes large

F. smaller worm consumes small

It would need to eat

[ ] prey

to have a higher than average chance of

passing its genes on to the next generation as

evidenced by it being a

[ ] prey

at that ocean level.

GO ON TO NEXT PAGE

66. At some point in the past, the two chaetognath species studied were a single species. The expression of genes which helped them survive resulted in two species.

- Based on the information, identify the limited resource which most likely resulted in their speciation. Explain the role that competition for the resource played.
- Describe a change in habitat that resulted from the process of competition.
- Describe how the process of competition resulted in physical differences that resulted in two species.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

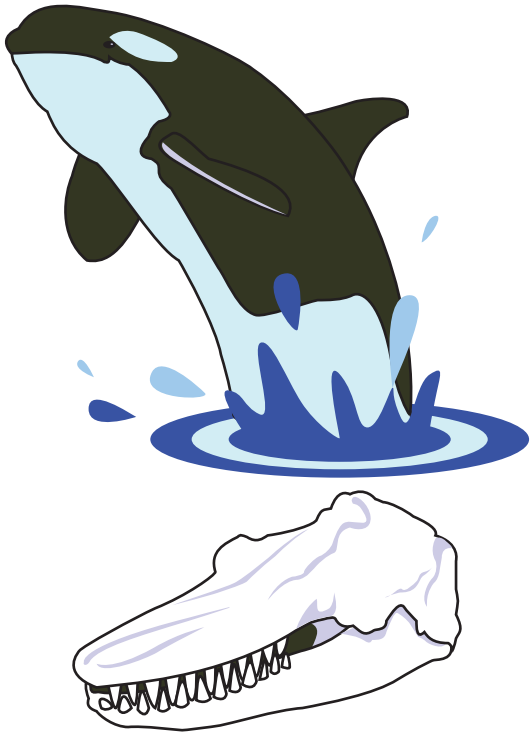
GO ON ▶

Whales are aquatic mammals. A student studies the odontocetes, a grouping of whales which includes bottlenose dolphins and killer whales. Unlike other whales, odontocetes have hard teeth. The student compares the body structures of these two species:

GO ON ▶

Figure 1. Body Structures

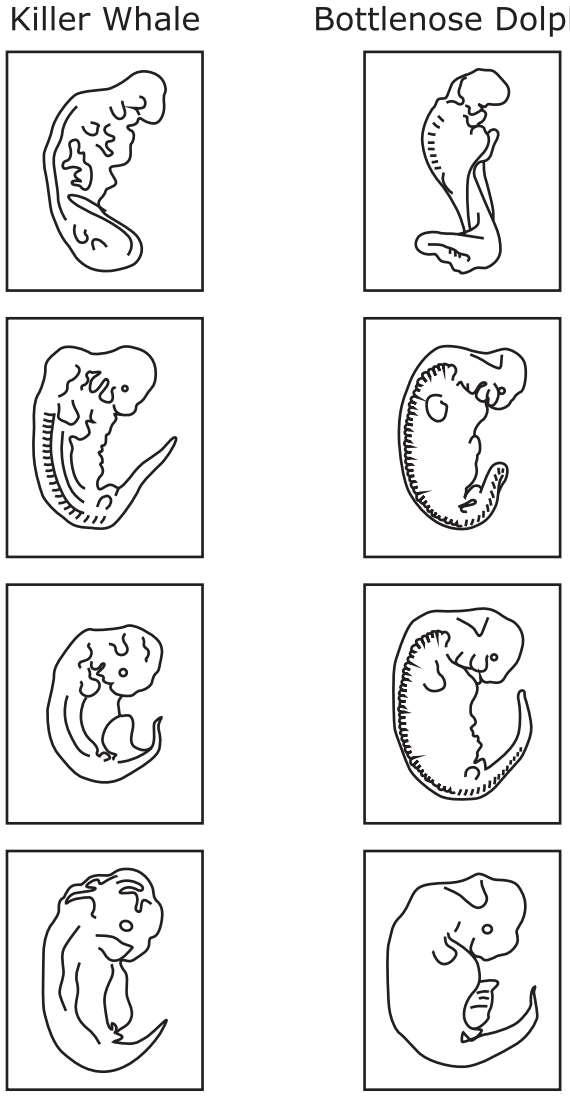
Bottlenose Dolphin



Killer Whale

A comparison of embryonic development in the species shows that both start to develop hind legs early in development, but then lose these structures before birth:

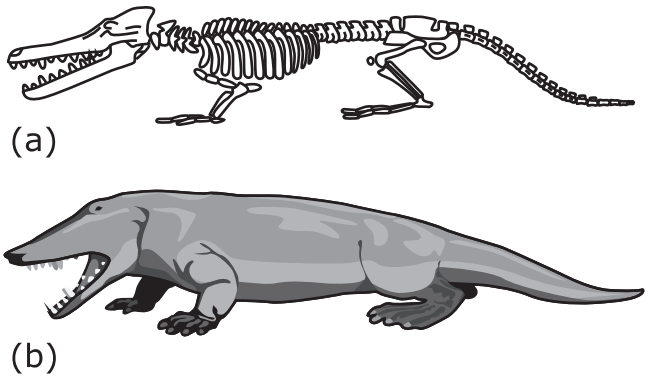
Figure 2. Embryonic Development



GO ON ▶

The student reads about the history of whales. The literature suggests that whales descend from land mammals which adapted gradually to an aquatic environment. Fossils of one very early whale species, *Ambulocetus natans*, show legs with hooves. The animal is thought to have spent much of its time swimming in the water, while retaining an ability to walk on land.

Figure 3. Evolutionary Ancestor



Ambulocetus Natans
(a) Skeletal reconstruction (Thewissen, 2002) and (b) Life restoration (Thewissen and Williams, 2002).

Further evidence for this history of whales comes from genetic comparisons. Comparison of DNA between the hippopotamus and the humpback whale reveals, for example, the following homologous sequences: ATAGGGAATT (hippopotamus) and ATAGGGACTT (humpback whale).

67. The student synthesizes the information to make a presentation about the evolutionary history of the odontocetes. The student's presentation will include diagrams drawing links between different organisms. The diagrams can include which of the following?

Ⓐ a link between killer whales and hippopotami based on DNA evidence

Ⓑ a link between humpback whales and hippopotami based on DNA evidence

Ⓒ a link between killer whales and humpback whales based on tooth structure evidence

Ⓓ a link between bottlenose dolphins and humpback whales based on tooth structure evidence

GO ON ▶

68. Compare the skeletons shown in Figure 3 and Figure 1. The skeleton in Figure 3 is from a species that appeared earlier on the evolutionary time scale. Based on these figures, what can be concluded about the teeth in these species?

Ⓐ Jagged sharp teeth are helpful for carnivores, and broad, flatter teeth are useful for herbivores and omnivores.

Ⓑ Smaller teeth are helpful for consuming small fish, and larger teeth are useful for consuming snails and crustaceans.

Ⓒ Teeth were helpful in environments with increased biodiversity, but not in environments with a limited number of species.

Ⓓ Teeth were once helpful for consuming prey, and this remained to be true over time despite changes in the environment.

69. In addition to anatomical evidence, studying patterns in DNA sequences provides what is considered good evidence for common ancestry among hippopotami and humpback whales. What is the percent similarity between the DNA sequences of these two species? Round your answer to the nearest percentage point. You may use the calculator to answer this question. Write the correct answer in the box.

[ ] %

GO ON ▶

70. A student is constructing an explanation of how the ancestor of the hippopotamus and the humpback whale evolved to become different species. Make use of the evidence to order the events below into an explanation. Write each statement in a box to show the steps in the correct order.

A. New species begin to form

B. Distinct sets of heritable adaptations accumulate

C. Natural selection acts in different patterns on existing genetic material

D. Different resource and threat patterns in distinct environments act on sub-populations

1. Despite high genetic uniformity, genetic variation exists

2.

3.

4.

5.

71. A student is using the graphic and textual evidence presented to construct an explanation of how *Ambulocetus natans* evolved over time. Write the correct answer in each box.

First Blank

- A. one
- B. one land-based and one water-based

Second Blank

- C. the land environment
- D. the aquatic environment
- E. the amphibious life cycle

Third Blank

- F. became more adapted to aquatic living
- G. increased in number on land and water
- H. learned aquatic behaviors which became heritable

The student explains that in the state shown in the diagram, the species was exposed to [ ] set of selection pressures, with [ ] ultimately providing the greatest survival opportunities. In response, the species over time [ ] .

GO ON TO NEXT PAGE

72. The student considers patterns of structure at multiple scales to explain the evolution of legs from:

hippopotamus/whale ancestor → *Ambulocetus natan* → odontocetes

Using the evidence presented, outline a presentation on this subject. Include:

- a description of historical changes to the limbs
- a description of anatomical and embryological evidence underlying the historical changes
- evidence that the gene for limbs has not disappeared

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

GO ON ▶

STOP


STOP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